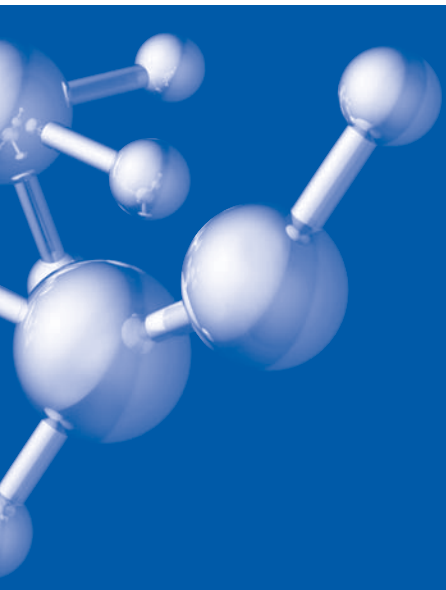
Lurgi



Edible Oil Technology – Oilseed Extraction & Edible Oil Refining

Model of Soybean Plant

Introduction

The worldwide production of edible oils and fats has risen much more strongly over the past decades than originally anticipated and the forecasts for the future continue to point upward. This increase is attributable to the growing world population and the rising demand in the growth regions, whereby the food industry accounts for the largest share.

Oilseed processing and refining plants are built to produce semi-finished and finished products from oil fruits and oilseeds. The design and construction of such plants require considerable expertise, good planning and partnership, from advice on the selection of the plant site to the start-up of the plant, including training of the operators and certification of product properties.

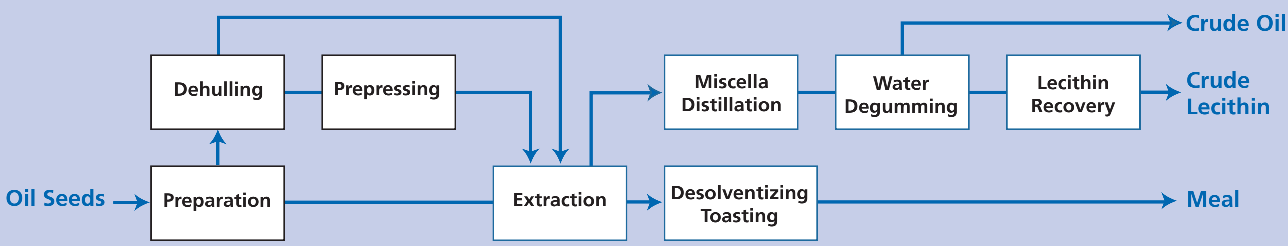
For more than 110 years now, Lurgi has been building process plants all over the world. These plants are characterized by a high technical standard and long-term availability. Lurgi is a reliable partner for the construction of complete plants or individual units, relying on its own experts and cooperating with local specialists.

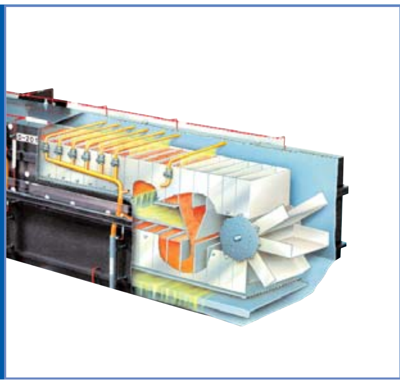
Lurgi Technologies - Solvent Extraction from Oilseeds

Lurgi – your partner for the engineering and supply of turnkey oil mills and individual process units
Active in the field of solvent-based oilseed extraction for many decades, Lurgi boasts a proud track record of about 200 solvent extraction plants built worldwide in the capacity range of 100 to 4,000 t/d, apart from numerous small units with processing capacities below 100 t/d.
Based on this experience and a continuous presence in the market, Lurgi's solvent extraction technology has been continuously developed further to meet specific customer needs. Our state-of-the-art solvent extraction plants feature:

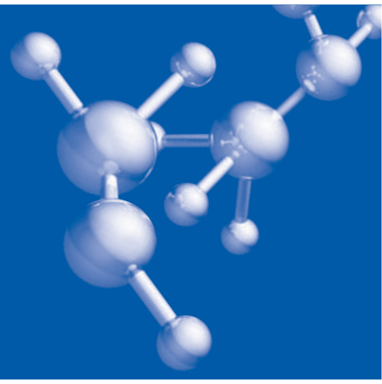
- ease of operation
- minimum personnel requirement
- high level of automation
- low energy consumption
- low maintenance cost
- fitness for processing all standard oilseeds

Oilseed Extraction





Sliding Cell Extractor



Highlights of Lurgi's Solvent Extraction Technology

Lurgi's sliding cell extractor offers the following benefits:

- dual pass shallow bed extraction
- meal refilling after half the extraction time gives better percolation of the material
- multiple solvent and miscella feed tubes per extractor stage
- long service life of rod-type screen plates
- no risk of clogging due to the conical shape (V-profile) of the rods
- few movable components
- delivery as fully assembled unit
- low capital cost

Pre-desolventizing the meal in a separate desolventizer permits:

- exact adjustment of the hexane content to optimum toaster inlet specifications
- optimum desolventizing efficiency based on the actual operating conditions

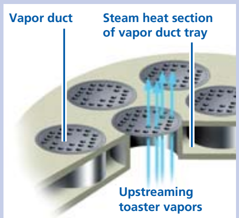
Extremely low steam consumption for meal drying, saving up to 20 % compared to the usual DT System

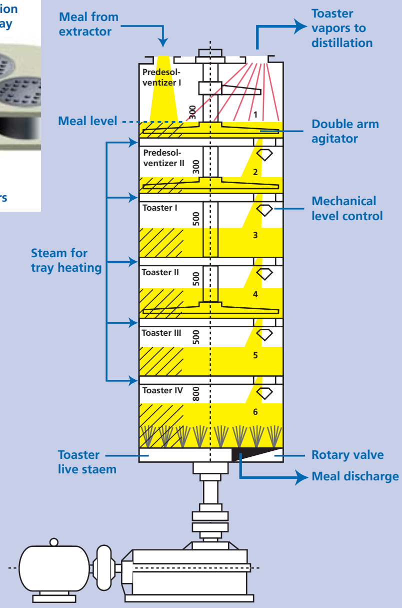
- low waste water volumes

Multi-stage countercurrent toasters feature the following advantages:

- low residual solvent content in the meal
- low moisture content in the meal
- low steam consumption for desolventizing/toasting
- fully automated operation

Sectional view of a toaster vapor duct tray





Desolventizer toaster with predesolventizer stages

Victoria, Serbia, 300 tpd, Refinery

Edible Oil Refining

The majority of the crude oils or crude fats of vegetable or animal origin extracted by pressing, solvent extraction or melting have to undergo a refining process before being suited for human consumption.

Depending on the type of oil, the treatment of the seeds and the oil and the extraction process used, fats and oils may contain undesired components that have to be removed. Such components may have a negative impact on the taste, odor and appearance of the product so that they reduce consumer acceptance and thus the usability of the product. In addition, they may also affect further processing.

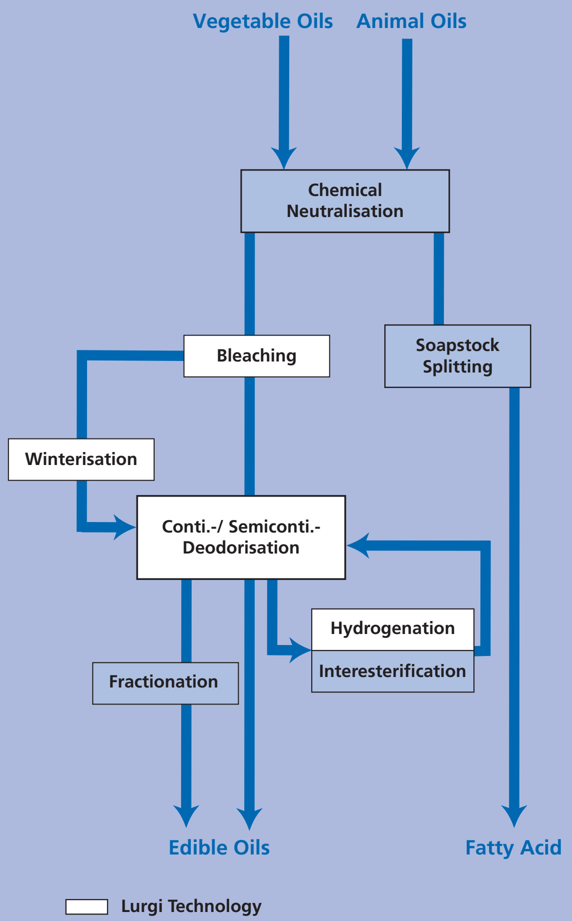
Refining can almost completely remove these undesired components from the oil. This can be achieved by two different ways and is basically dependent on the fatty acid content.

Oils and fats with a high free fatty acid (ffa) content will preferably be treated taking the physical oil refinery route. Fatty acid distillate is produced as a by product.

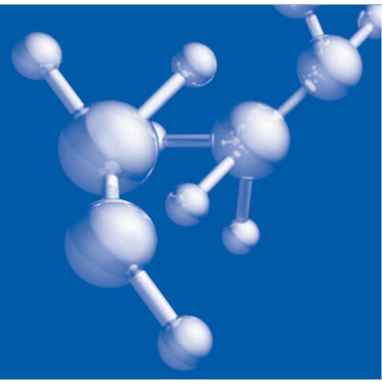
Oils and fats with a low free fatty acid (ffa) content will preferably be treated taking the chemical oil refinery route. Soap stock is produced as a by product and requires after-treatment (e.g. in an additional soap stock splitting plant).

In the refinery process for vegetable and animal oils and fats, different single process steps are combined. Processes for increasing and stabilizing the oil quality, e.g. for the removal of undesired components such as:
- free fatty acids (chemical or alternative physical route)
- phospholipids (gums – chemical route)
- color pigments (bleaching plant)

Chemical Oil Refining



IOI, Malaysia, 1.500 tpd,
Refinery



- metal ions (bleaching plant)
- waxes (winterization plant)
- volatile odorous and taste components (deodorization plant)

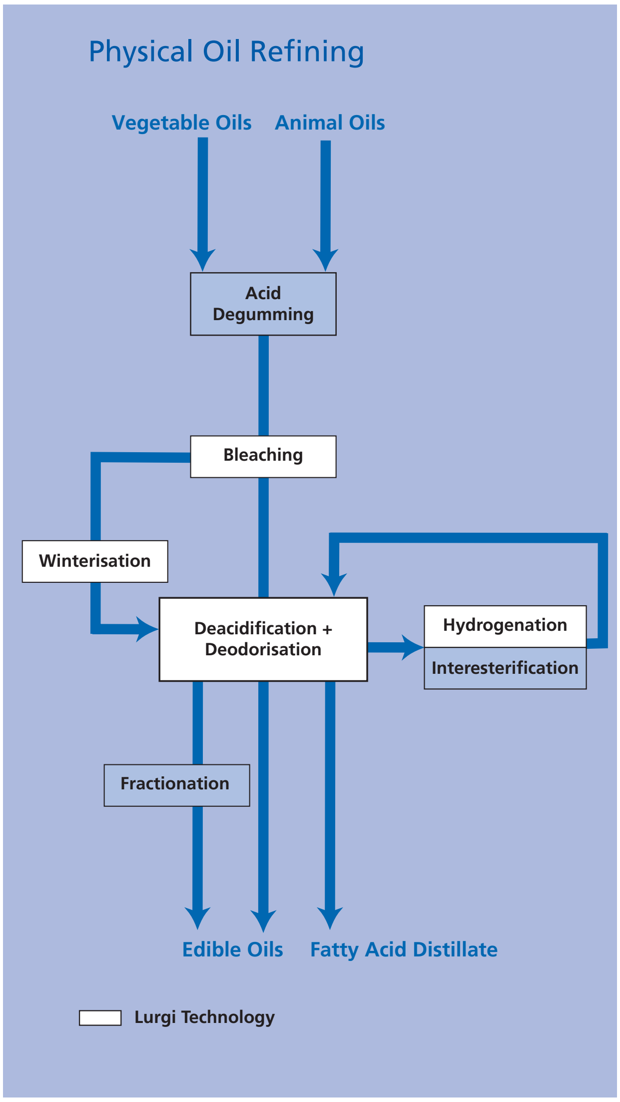
Processes for optimizing the product quality such as:
- fractionation plant
- hydrogenation plant
- interesterification plant

Neutralizing

If required, gums still present in the product can be coagulated by adding mineral acid before the actual neutralization. The free fatty acids in the oil are subsequently saponified by the addition of an alkali. The soap stock is separated from the oil in a first centrifuge. The oil is then washed with water and the wash water is separated in a second centrifuge. The oil is subsequently dried under vacuum. The oil treated this way can be further processed in a downstream traditional refining stage (e.g. bleaching, deodorizing). The soap stock is then separated in subsequent process stages.

Acid Degumming

The vegetable oil must be degummed before being further refined. In a continuous process the oil, preferably oil already water-degummed, is treated by adding phosphoric acid and a calculated quantity of sodium hydroxide solution. The non hydratable phosphatides are converted to their hydratable form by means of the phosphoric acid. The accumulated sludge (gums) is removed in a centrifuge and then partly recycled. The oil is then washed with water and the wash water is separated in a second centrifuge. The oil is subsequently dried in a vacuum. The oil treated this way can be further processed in a downstream physical refining stage (e.g. bleaching, deacidification / deodorizing).



Pressure Leaf Filters

Continuous Bleaching

Process principle:

Substances, accompanying residual phosphatides, color pigments, etc. are removed from the oil and adsorbed to the highest possible extent by means of phosphoric acid and natural adsorbent (bleaching earth and / or Trisyl®).

Best oil quality due to:

- Moderate thermal treatment of the oil in the bleaching vessel under vacuum conditions
- Optimized bleaching temperature and retention time
- Mixing of natural adsorbent (bleaching earth) to the oil under vacuum conditions to prevent undesired reactions caused by the presence of air at bleaching temperature (oxidation)
- Smooth suspension of natural adsorbent in the oil by mechanical agitation and direct steam agitation
- Acid activation of natural adsorbent (bleaching earth) through contact with direct steam in the bleaching vessel

High plant efficiency through:

- Optimized heat recovery between incoming and outgoing oil
- Heat exchange study (value engineering) for the whole bleaching plant (optional)
- Minimum consumption of natural adsorbent
- Fully automated filtration program sequence, including fully automated filter cleaning
- Continuous filtration process realized in dual-unit pressure leaf filters

Options:

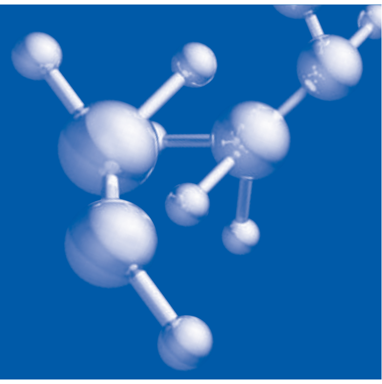
- Various conveying systems for natural adsorbent available
- Additional treatment of oil with Trisyl®
- Various vacuum generating concepts available to minimize motive steam consumption and waste water amount
- Integration of the bleaching section into a complete edible oil refinery plant to optimize heat exchange and plant layout

Typical Utility Consumption Figures *

Plant capacity	100 – 1,500 t/d
Live steam, 4 bar g	4 kg
Steam for vacuum generation, 10 bar g	4 - 6 kg
Steam 4 bar g – for filter blowing	5 kg
Steam 4 bar g – for heating purposes	acc. to heat exchange concept
Cooling water, ΔT = 10	2 m³
Electric power	4 kWh
Instrument air, 6 bar g	2 Nm³
Bleaching earth	6 - 10 kg
Trisyl®	1 - 2 kg
Phosphoric acid, liquid, conc. 75 % - 85 %	1 - 2 kg
Footprint required	12 m x 12 m

*) per 1,000 kg of feed material

Model Plant Winterization



Continuous Winterization

Process principle:

The bleached oil is cooled down to winterization temperature in order to allow formation of wax crystals.
After a certain retention time at low temperature, the wax crystals are separated from the oil by means of pressure filtration. By processing feed oils, wax contents of between 3,500 ppm and 500 ppm can be.

Best oil quality due to:

- Optimized residence time at low temperatures to form wax crystals
- Use of filter-aid material for a dual purpose: to enhance wax crystal growth and to support downstream filtration
- Increase of oil temperature directly before filtration. Positive effects: lower oil viscosity, ease of filtration and minimized oil losses

High plant efficiency through:

- Optimized heat recovery between the incoming and outgoing oil
- Optimized oil cooling by glycol-water operated chilling cycle
- Heat exchange study (value engineering) for the whole winterization plant (optional)
- Minimum consumption of filter-aid material
- Continuous filtration implemented by means of pressure leaf filters of dual-unit design
- Fully automated filtration program sequence, including fully automated filter cleaning

Options:

- Integration of winterization section

Typical Utility Consumption Figures *

Plant capacity		50 - 500 t/d
Cooling water, ΔT = 10 K		8 m³
Steam for cake blowing 3 bar g		acc. to requirements
Filter aid material	for pre-coat generation	1 kg / m² of filter area
	for body-feed during filtration	10 times wax content
Electric power		20 kWh
Instrument air, 6 bar g		2 Nm³
Compressed air, 3 bar g		10 Nm³
Footprint required		12 m x 12 m

*) per 1,000 kg of feed material

Transportation of Semi-Continuous Deodorizing Unit

Continuous Deodorizing

Process principle:

Undesirable odors and flavors as well as free fatty acids (ffa) are removed from the degummed and bleached seed oil. Deacidification / deodorization is achieved by carrier steam distillation

Best oil quality due to:

- Moderate thermal treatment of the edible oil by heating up to deodorizing temperature under high vacuum conditions
- Extreme limitation of air access to the deodorizer column to prevent oxidation of the oil
- Metering of citric acid into the oil under vacuum conditions in order to lower its oxidation rate / achieve superior quality and stability of the deodorized oil

High plant efficiency through:

- Highly efficient heat exchange and deodorizing in the deodorizer column by means of mammoth pump circulation systems
- Optimized heat recovery between incoming and outgoing oil
- Heat exchange study (value engineering) for the whole plant (optional)

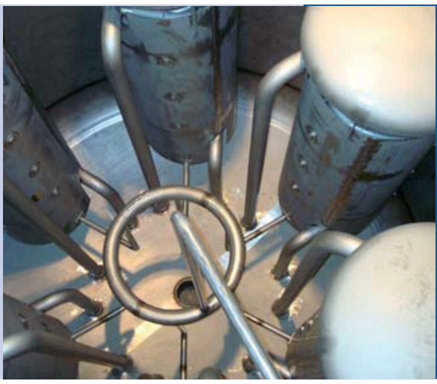
Options:

- Using a purpose-designed stripping column for oils with high contents of free fatty acids
- Automatic stock change
- Various vacuum generating concepts available to minimize motive steam consumption and waste water amount
- Integration of deodorizing section into a complete edible oil refinery plant to optimize heat exchange and plant layout

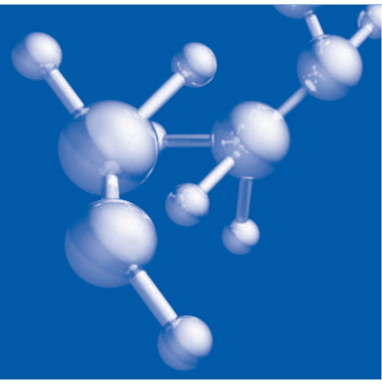
Typical Utility Consumption Figures *

Plant capacity		100 - 1,000 t/d
Live steam, 3 bar g		8 - 12 kg
Steam for vacuum generation, 10 bar g		80 - 110 kg
Cooling water,	for product cooling	8 - 10 m³
⊿T = 10 K	for vacuum generation	12 - 17 m³
Electric power		3 - 5 kWh
Instrument air, 6 bar g		2 Nm³
Light fuel oil		3 - 5 kg
Natural gas		3.6 - 6 Nm³
Citric acid (crystalline)		acc. to requirements
Footprint required		6 m x 12 m

*) per 1,000 kg of feed material



Deodorizer internals
during manufacturing



Semi-continuous Deodorizing

Process principle:

Undesirable odors and flavors as well as free fatty acids (ffa) are removed from the degummed and bleached seed oil. The deodorizing section is designed to process single batches of oil in semi-continuous mode. This allows charging of different kinds of feed oils without interruption during normal operation. Advantage: emptying of the deodorizing column for stock change is not required.

Best oil quality due to:

- Extreme limitation of air access to the deodorizer column to prevent oxidation of the oil
- Metering of citric acid into the oil under vacuum conditions in order to lower its oxidation rate / achieve superior oil quality and stability of the deodorized oil
- Extremely low contamination of each batch
- Cooling of the deodorized oil under vacuum

High plant efficiency through:

- Highly efficient heat exchange and deodorizing inside the deodorizer column by means of mammoth pump circulation systems
- Optimized heat recovery between incoming and outgoing oil
- Controlled semi-continuous operation, avoiding loss of time for stock change
- Plant design for fully automated operation

Options:

- Various vacuum generating concepts available to minimize motive steam consumption and waste water amount
- Minimizing utility consumption figures by double heat exchange inside the deodorizer column

Typical Utility Consumption Figures *

Plant capacity		100 - 1,000 t/d
Live steam, 3 bar g		8 - 12 kg
Steam for vacuum generation, 10 bar g		80 - 110 kg
Cooling water,	for product cooling	8 - 10 m^3
ΔT = 10 K	for vacuum generation	12 - 17 m^3
Electric power		3 - 5 kWh
Instrument air, 6 bar g		2 Nm^3
Light fuel oil		3 - 5 kg
Natural gas		3.6 - 6 Nm^3
Citric acid (crystalline)		acc. to requirements
Footprint required		6 m x 12 m

*) per 1,000 kg of feed material

Dryer System

Continuous Deacidification

Process principle:

In the deacidification section, undesirable free fatty acids (ffa) are removed from the degummed and / or bleached oil. The plant is operated continuously in all processing stages. Deacidification is achieved by carrier steam distillation.

Best oil quality due to:

- Moderate thermal treatment of the edible oil by heating up to deacidification temperature under vacuum conditions to minimize thermal stresses
- Short residence time of the edible oil under high temperature conditions to minimize thermal stresses
- Extreme limitation of air access to the deacidification column to prevent oxidation of the oil

High plant efficiency through:

- Highly efficient heat exchange and deodorizing in the deacidification column by means of mammoth pump circulation systems
- Optimized heat recovery between incoming and outgoing oil, using a purpose-designed external falling-film heat exchanger
- Heat exchange study (value engineering) for the whole plant (optional)

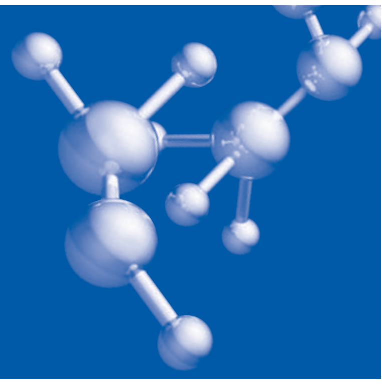
Options:

- Various vacuum generating concepts available to minimize motive steam consumption and waste water amount

Typical Utility Consumption Figures *		
Plant capacity		100 – 1,500 t/d
Live steam, 3 bar g		6 kg
Steam for vacuum generation, 10 bar g		80 - 110 kg
Cooling water,	for product cooling	8 - 10 m³
ΔT = 10 K	for vacuum generation	12 - 17 m³
Electric power		3 - 5 kWh
Instrument air, 6 bar g		2 Nm³
Light fuel oil		3 - 5 kg
Natural gas		3.6 - 6 Nm³
Citric acid (crystalline)		acc. to requirements
Footprint required		6 m x 12 m

*) per 1,000 kg of feed material

Akzo Nobel, Malaysia,
Hydrogenation Unit



Batch Hydrogenation

Process principle:

The vegetable oils are hydrogenated by accumulating molecular hydrogen on the double bonds of acid molecules at pressures of max. 6 bar, temperatures close to 200 °C and in the presence of a catalyst.
Partial and selective degree of saturation with hydrogen can be achieved.
The plants are operated in batch mode.

Best oil quality due to:

- Optimized residence time
- Use of polish filter to remove nickel catalyst
- Hydrogen is not vented after each batch but after accumulation of impurities only
- Maximum heat recovery
- Hydrogenation is conducted following the "dead end" procedure which means that no circulation and no purification of the hydrogen will be necessary

High plant efficiency through:

- Low iodine value (I.V.)
- Low catalyst consumption
- Low hydrogen consumption
- Low utility consumption
- Reduced thermal affection of the product
- Fully-automated filtration program sequence, including fully-automated filter cleaning
- Particular hydrogenation
- Selective hydrogenation
- Optimal mixing of oil, hydrogen and catalyst
- Short reaction time

Options:

- Heat recovery between incoming feed and outgoing hydrogenated final product
- Batch sizes vary between 50 -100 % of reactor size

Typical Utility Consumption Figures *	
Plant capacity	8 -12 t per batch, batch time 3 -6 h
Cooling water, $\Delta T = 10$ K	10 m³
Steam 11 barg for heating	acc. to requirements 0 kg at reduction of I.V. = 40 50 kg at reduction of I.V. = 20
Steam for vacuum	30 kg
Electric power	15 kWh
Instrument air, 6 bar g	2 Nm³
Hydrogen per unit I.V. reduced	approx. 1.05 m³ (0°C, 1.013 bar)
Catalyst as pure nickel	0.2 – 0.6 kg
Footprint required	12 m x 12 m x 15 m
*) per 1,000 kg of feed material	

Lurgi is a leading technology company operating worldwide in the fields of process engineering and plant contracting. The strength of Lurgi lies in innovative technologies of the future focusing on customized solutions for growth markets. The technological leadership is based on proprietary technologies and exclusively licensed technologies in the areas gas-to-chemical products via synthetic gas or methanol and synthetic fuels, petrochemicals, refinery technology and polymer industry as well as renewable resources/food.

Lurgi is a member of the Air Liquide Group.

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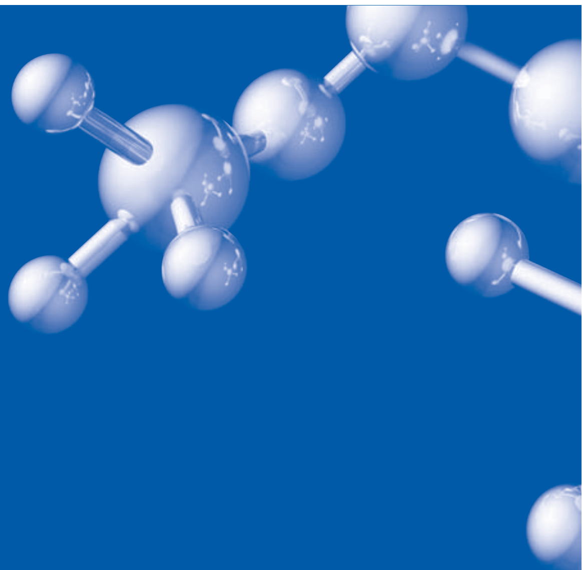

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